Will be finished and submitted to Livestock Science spring 2022

Assessing economic consequences of cow-calf contact systems in dairy production using a stochastic partial budgeting approach

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Introduction

One frequently stated reason for employing early separation of dairy cows and calves is that this strategy is considered to result in a higher amount of saleable milk, which in turn will increase farm profits. Cow-calf contact (CCC)-systems is any type of housing or management system allowing calves contact with their dam or with foster cows during early life (Sirovnik et al., 2020). To investigate the economic consequences strategies allowing cow-calf contact (CCC) was compared with a scenario separating cows and calves immediately after birth.

Partial budgeting is a financial tool used to assess the costs and benefits associated with a specific change in an individual enterprise within the business operation. This tool specifically focuses on the implications of the intended change in a business operation by comparing the benefits and costs resulting from implementing the alternative, with respect to the current practice (Dhoubhadel & Stockton, 2010).

The primary objective of this study was to use stochastic partial budget analysis to estimate the cash impact for herds allowing cow-calf contact compared to a situation with early cow-calf separation. As a secondary objective, we conducted a sensitivity analysis to investigate the net cash impact the different scenarios.

Material and method

A farm simulation model for an organic dairy herd, constructed in Microsoft Excel 2016 (Microsoft, Redmond, WA), was used to evaluate the economic impact for herds allowing CCC. A generic study farm with 41 annual cows (including 8 dry cows) of dual-purpose breed producing 7000 kg ECM per cow and lactation was used to evaluate different calf rearing scenarios. These scenarios were created based on the most common CCC strategies identified in a survey performed in seven European countries including 104 CCC dairy herds (Eriksson, unpublished). The following CCC scenarios were included:

Scenario 1: Dam rearing with contact at milking (15 minutes twice a day for 115 days);
Scenario 2: Initial dam rearing with full contact, calves are manually fed 8 liters of whole milk from 21 days (survey median) of age;
Scenario 3: Mixed rearing with 24 h contact, calves initially kept with their dams and moved to foster cows at 9 days (survey median) of age

The baseline comparison was an organic herd practicing early separation from the mother during the first day after calving. Calves were manually fed 8 liters of milk for 12 weeks according to Swedish recommendations (KRAV, 2021).

The basic partial budget model was built using economic data from Agriwise (2020) and biological parameters from the literature, complemented with survey data (Eriksson et al., unpublished) and input from experts in the field. The partial budgeting framework allowed us to isolate the effects on the contribution margin of the different calf rearing strategies by only focusing on the economic variables likely to depend on the specific rearing strategy. The model included both deterministic and stochastic variables. A stochastic model takes the parameter variation into calculation to generate results with a distribution, representing the uncertainty in results (Liang et al., 2017). The stochastic elements of the model were handled with @Risk 8.1 (Palisade, Ithaca, NY), an application in Microsoft Excel, which performs risk analysis using Monte Carlo simulations. Model simulations were run using 5000 iterations using Latin Hypercube sampling with a static seed of 31 517 to ensure that all simulations provided repeatable results. The input variables and their units and distribution are listed in table 2.

Table 1. Description of scenarios used to evaluate economic consequences of CCC-systems

Item	**Baseline**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Suckled dam (days)	1	115	21	9
Suckled foster (days)	0	0	0	106
Milk feeding (days)	90	0	94	0
Manually fed milk (kg/d)	8	0	8	0
Suckled milk (kg/d)	0	5.1 (Range: 3-10)	10.9 (Range: 9.2-12)	Dam: 10.9 (Range: 9.2-12) Foster: 8.5 (Range: 7.0-10)
Median mortality, 0-90 d (deaths/100 calf-years)	3.1	0 (Range: 0-14)	2 (Range: 0-14)	0 (Range: 0-4.5)

We assumed that changes needed for reconstructions of buildings were negligible. A sensitivity analysis of the impact of the stochastic parameters on outcome values was performed using the @Risk software (Palisade, Ithaca, NY).

Table 2. Overview of prices used in the partial budget model

Item	Data	Source
Concentrate (€/kg)	0.29	Agriwise, 2020
Home-produced silage (€/kg DM)	0.12	Agriwise, 2020
Milk price (€/kg)	0.44	Agriwise, 2020
Young stock sales (€/kg)	3.94	HK Scan, 2021

Table 3. Contribution margin in three different calf rearing systems

	Baseline	S1	S2	S3
Milk consumed by calves (kg)	25 536	22 734	33632	35621
Costs				
Forage	1408	1515	1504	718
Concentrate	2408	2590	2572	1525
Revenues				
Sold milk	105563	106788	102022	101152
Contribution margin	101 746	102683	97946	98909
Change		+937	-3800	-2837

Results and discussion

Feed consumption, morbidity and mortality differed between the strategies, but it was milk consumption that affected the farm's economy the most (Table 3). As expected, milk income decreased when the calves received a larger milk supply, which was the case in strategies 2 and 3. With strategy 1, on the other hand, the calves consumed less than 8 liters of whole milk per day, which was economically advantageous for the farm.

The partial budget analysis was done in Excel using @Risk to run simulations. This plug-in program allows the stochastic input variables to vary according to the defined distributions and gives an estimation of the contribution margin in the three systems. The analysis presented is restricted to one year and there are several factors affecting the economic output which are not taken into consideration in this model. Calf heifers reared in a CCC system could for example have a lower age at first calving due to higher average daily weight gain and reduced disease incidence during the rearing period. The higher milk feeding during the rearing might also result in a higher milk production and a more robust cow with increased longevity in a longer perspective and these potential benefits are not included in this restricted model.

A majority of the farmers in the survey by Eriksson (unpublished) perceived cow and calf health to be same or better in CCC-systems compared with a system where cows and calves are separated within one day after birth. They also stated that a CCC-system was not more time consuming than a system where cows and calves were separated directly after birth.